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A New Surgical Open Treatment of the Pulmonary Tuberculous Cavities and Caseous Lesions by making Drainig Pit (2nd Rep.)

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Introduction

We have established a new surgical open treatment for tuberculous cavities and caseous lesions which have not yet become cavities. By this method we have operated on 75 cases, during period from July 1951 to July 1953.

We made our preliminary report at the 27th Annual Meeting of the Japanese Association for Tuberculosis in April 1952, the second report at the 5th Annual Meeting of the Japanese Association for Thoracic Surgery in October 1952, and we described the details of the indication, technique, and results of this operation in the Japanese Medical Journal, No. 1475, 1952.

In this article, we want to state the grounds, upon which we developed this method, and then include several new findings which appeared after the above reports.

For several years excellent anti-tuberculous remedies have been found one after another, among which is the striking development of direct therapy on tuberculos lesions. The resent development of direct surgical therapy of pulmonary tuberculosis is specially notable.

There are two chief directions of development in the surgical therapy of pulmonary tuberculosis: one is called "draining therapy," viz., Monaldi's therapy,

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Maurer's therapy and cavernostomy etc., which are chiefly performed to drain lesions; we temporarily call other "resection therapy," viz., pneumonectomy, lobectomy, partial resection, segmental resection, cavernectomy, and enucleation of tuberculum etc., which are chiefly performed by the resection of lesions.

This may not be the time to evaluate the two lines of therapy of pulmonary tuberculosis, since their indications, operating methods and especially long-term results must still be clarified, but we wish to give our opinion this problem on the occasion of the introduction of our method.

Draining therapy mainly achieves drainage from a cavity, whereas resection therapy chiefly accomplishes removal of the entire lung lesion. Therefore as a radical cure of pulmonary tuberculosis, the latter method is theoretically obviously superior to the former.

That is draining therapy is only hastens and promotes a natural cure, and is therefore thought to be inferior to resection therapy, which is a radical operation.

But unavoidably resection therapy also has a few defects: the indications are limited, the method is difficult, the extent of invasion of the operation is very great and the deadspace after resection must be managed.

It is, however, an interesting fact known to all that these defects in resection are the good points in drainage therapy. The greatest defect of drainage therapy, namely that healing is not always radical, is a good point of resection therapy.

But from the point of view of histological pathology, draining therapy is exactly the most natural resection or enucleation of a lesion. as draining leads to the removal of caseous substance and the rearrangement leads to healthy granulation. The following question then arises:

Why can we not gain a radical cure by means of draining therapy?

The answer to this question is simple.

In resection therapy, the amount of lung tissue resected includes the entire cavity and caseous lesion, but in draining therapy up to now, the cavity alone is object of drainage.

The more extensive caseous lesions never heal perfectly cicatricially with collapse therapy; and also when open treatment is used for the chief lesions the remaining smaller lesions heal cicatricially with difficulty.

Our experiments show this fact, and it has recently been substantiated by many others.

It may therefore be proposed, that not only cavities, but more extensive caseous lesions must but be also treated openly in order to heal radically by draining therapy as is done by resection.

In other words, the draining therapy is needful for radical cure, which drains the contents of all lesions having the possibility of making worse in the future.

Therefore, holding this opinion, we have treated extensive caseous lesions with or without cavity by the open method, and have studied the effect.

This method proved more effective in its results than we had first supposed. We have decided to name this method tentatively the "Open Drainage of the Affected Lung Ares by Means of a Surgically Constructed Pit."

(Patients call this method the "Tunnel Therapy.")

Next, the techhique of construction the draining pit, the open treatment, etc., will be described.

I. Operative Technique

(1) *Preparation*

Two things must be determined before a patient is operated upon by this method.

First, it must be established whether or not the pleura overlying the site selected for the establishment of the draining pit is adherent.

If any free pleural space exists the operation must be performed after an adhesion is artificially produced. For artificially producing a pleural adhesion, it is our practice either to inject 10 to 30 cc. of the patient's own blood plus penicillin one to three times into the pleural cavity, or to expose the parietal pleura then pack it with gauze and renew it daily for several days.

Second, attention must be paid to the precise localization of the main lesion. This caution is a matter of course, and not much need be said about this.

(2) *Preoperative Treatment*

Before operating upon a case with exudative disease by this method, it is natural to administer the anti-tuberculous remedies for a certain period of time. It is advisable, however, to begin the administration of anti-tuberculous remedies several days in advance of the operation to prevent the hematogenous or intracanalicular spread of the disease.

The subcutaneous injection of Ringer's slution or blood transfusion preoperatively is performed as usual.

For inducing basal anesthesia, injections of 0.3 cc. of "Pantopon Scopolamin" (4% pantopon, 0.06% scopolamine) an hour before, and 0.3 cc. of the same half an hour before the operation, were found sufficient.

(3) *Skin Incision and Extrapleural Pneumolysis*

The skin incision may be anterior, lateral, or posterior.

We had chiefly employed the anterior incision when we originated this method, because of the case of open treatment after constructing the draining pit, and because the M. pectoralis major could be used as the pedunculated muscular flap.

But the anterior incision has several defects; 1) it is difficult to detect the

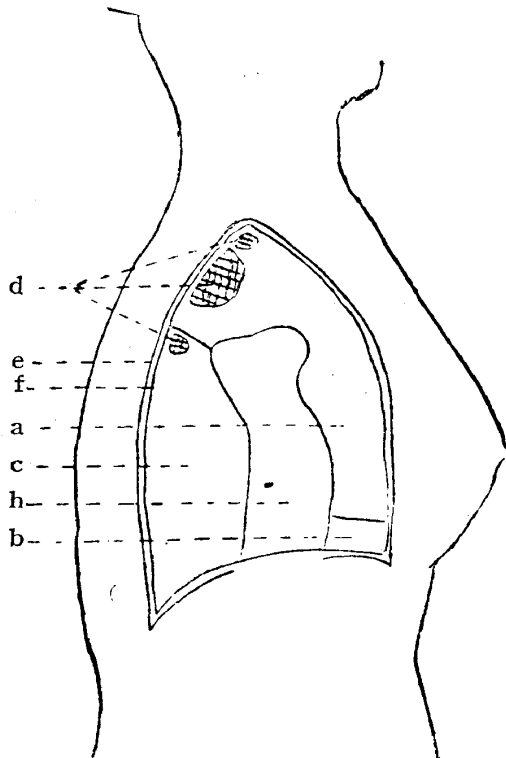
objective, as the lesion lies in the most cases posteriorly; 2) a scar on the anterior chestwall is cosmetically undesirable; and 3) a free pleural space is often found anteriorly although posteriorly the pleural cavity is adherent.

Therefore, we are at present to employing the posterior incision except in certain specific cases, such as a giant cavity, anterior lesions, etc.

The superiority of the posterior incision lies in the facts that, in the most cases, the lesion can be easily reached, extrapleural retracting and suturing of lung tissues can be easily accomplished than the situation form of the pit might be selected as much as the operator likes, and that a posterior scar is not conspicuous.

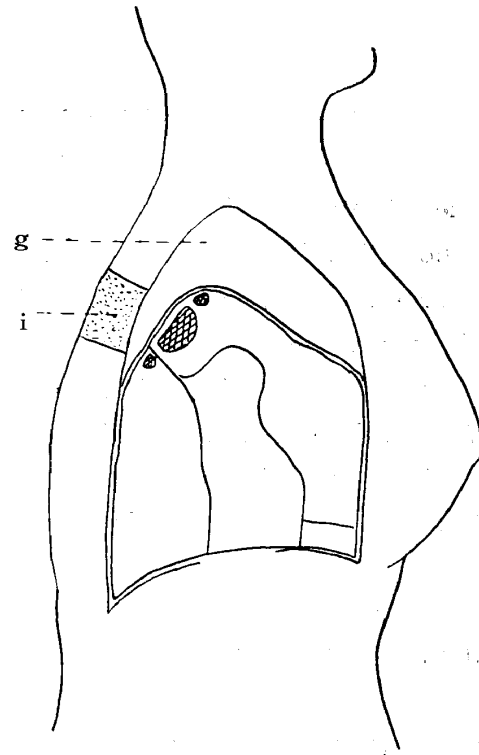
The open treatment through the back is generally difficult in cases of lesions in the subscapular part or apex. Therefore, we had through that open treatment through the back for lesions in the subscapular area or in the apex was impossible, but at the present time, the above mentioned difficulty has been reduced by the techhic. which retracted and sutured extrapleurarly the lung tissues, thereby transferred the aimed lesion at the point between shoulder-blade and back-bone. (Fig. 1, 2, 3, 4)

Fig. 1 Before the operation



a; upper lobe b; middle lobe c; lower lobe d; the aimed lesions e; parietal pleura f; visceral pleura h: heart

Fig. 2 After the extrapleural pneumolysis



g; extrapleural cavity i: entrance of thorax

Fig. 3 After saturating and retracting
of lung tissues

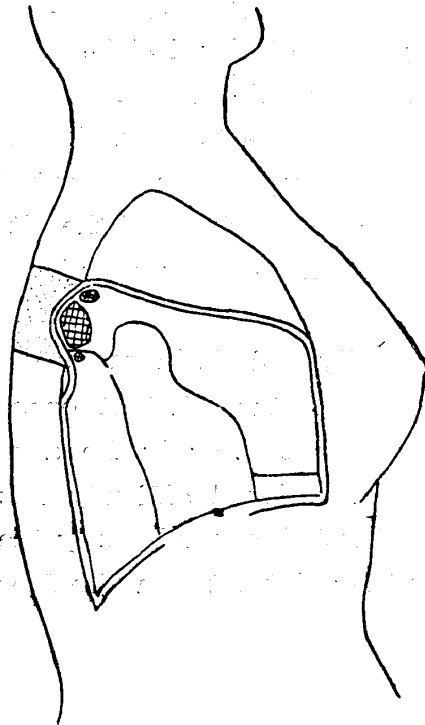
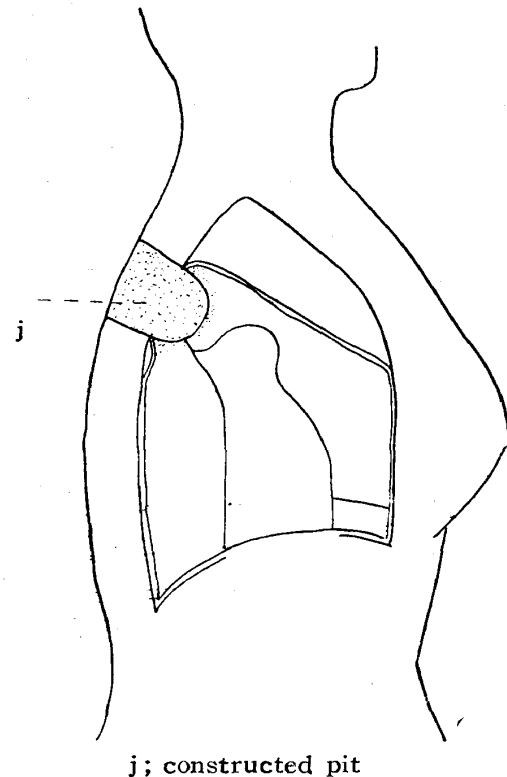


Fig. 4 After constructing the pit



We will refrain from discussing the lateral incision, as we have used it in only a few cases.

The length of skin incision is 5 to 10 cm. in the case of anterior or lateral incision, and 10 to 15 cm. in posterior incision.

When the pleura is exposed, it is first examined to determine the presence or absence of a free pleural space.

In case complete pleural adhesion is found, extrapleural pneumolysis is performed over a large enough area to permit localizing the main lesion. We may encounter some cases in which pleura considered adhesive [preoperatively proves to enclose a free space. It is possible in such a case to continue the operation by suturing a certain portion of the pulmonary pleura to the chest wall if the extent and condition of the free space permit, the suture separating the selected site from the rest of the free space.

However, for the sake of greater safety, the treatment should preferably be limited to packing with gauze for the time being, further entry into the chest being postponed until the adhesion becomes complete.

(4) *Identification of the Main Lesion*

In order to localize the position of a cavity, we use the following four means: inspection, palpation, compression, probing with a needle.

It will be ideal if fluoroscopy can be combined with these methods of localiza-

tion.

Among the above four means of localization, palpation and compression test are most commonly practiced and most sharply reveal the site of a cavity.

In case these methods of localization through the pleura fail to identify the main lesion, it is of help to repeat the search after the lung is entered a little through the site determined roentgenographically as lying just above the lesion in question. The compression-test and probing with a needle are often of no use when a cavity does not exist. In such cases the lung should be entered either under guidance by fluoroscopy, or by comparing the result of palpation with a previously obtained roentgenographic view. By doing so we have achieved the purpose of the operation in almost all instances.

(5) Construction of the Draining Pit

At first we had used to construct the pit entering the aimed lesions directly, thereafter treat openly not only the main lesions but the caseous around the pit also. It is that, after constructing the pit for the main lesions, the lesions around the pit treated openly altogether with the main lesions by artificial destructing the partition between the pit. (We call this method as Direct Method of our operation.)

But, at present, we are used to saturate and retract extrapleurally in the almost cases all lesions to be treated openly, then incise at a stretch these lesions with often resecting a partial and construct the pit as Fig. 1~4. (We call this method as Saturating and Retracting Method of our operation.)

Saturating and Retracting Method has been adopted for the reason, which open treatment through the constructed pit and closure of the draining pit track by plompage with a pedunculated muscular flap have been more easily performed and we have been acquired the better results on the histopathological point.

Direct Method is adopted for only a few special cases.

The ideal shape of a pit should be funnel-like, with a wide neck and a narrow bottom. It is minimal necessary condition for a draining pit to meet a condition that a diameter of the bottom is as one of the neck. According to our experience most of the cases failing to meet this condition did not attain the purpose of the operation, and required subsequent thoracoplasty.

It is our opinion that if we have to contemplate establishment of a pit with a neck exceeding 5 cm. in diameter, it is better to construct two pits from different directions. In case the neck of a pit track is narrow either by the intercostal tissues or by the musculature of the chest wall resultant disturbance in visualization of the track and in renewing the gauze, a partial resection or suturing of these tissues is recommended. If possible, draining bronchus should be ligated.

When the construction of a pit is completed, the wound is either packed

with iodoform gauze or sprinkled with powder of chemotherapeutics, and then packed with dry simple gauze.

Injection of streptomycin or penicillin into the surrounding tissues of the pit, particularly subcutaneous tissues and muscles, is very necessary.

For sturing lung and other tissues we usually use silk thread without any particular disadvantage.

II. Post-Operative Course of Open Treatment

The postoperative course of the open treatment of lesions constitutes the most important part of this treatment.

It is hardly an exaggeration to say that the treatment in this period and the selection of cases to be treated determine the success of this method. The open treatment chiefly aims at sufficient drainage of pus from the caseous lesions around the pit.

In order to drain pus and exudate sufficiently, a particularly tight and snug packing of gauze should be obtained at the bottom part of the pit track, so that the blood and exsudate lining the pit wall will not drain through the draining bronchus, into the bronchus and trachea. As to the means of obliterating a draining bronchus, after having tried silver nitrate, jodoform, electric cauterization, and a ligature of a draining bronchus, we chose a 1 to 2 per cent solution of silver nitrate or ligature as the best means.

In some cases a draining bronchus remains wide open for one or two weeks in spite of the above methods of obliteration; these cases often necessitate thoracoplasty.

There is a report by a reviewer of this method that the application of this method to cases with huge and cirrhotic cavities failed to produce a good result, and that he had to resort to a combined thoracoplasty.

It should be emphasized, however, that the cases in question were the type of disease that can respond to a thoracoplasty after first being operated upon by this method.

As for the gauze tamponade, iodoform gauze is exclusively used for several days following the operation. In this period anti-tuberculous remedies should be administered generally, not locally.

It is after bleeding subsides and exudation decreases that a tampon is taken by simple gauze and anti-tuberculous remedies are sprinkled over the wound, the general administration being continued. We believe that jodoform gauze should be replaced by simple gauze preferably earlier than the end of the first week, for a prolonged use of iodoform gauze often causes headache, nausea and other side-actions of iodine.

The tampon by simple gauze should be taken softly and snuggle so that the

pit becomes narrower by reexpansion of lung.

Closing the wound while there is still a considerable amount of caseous lesions around the draining pit should be avoided. Closure of the pit should be contemplated only after the surrounding lesions within the assailable limits are treated through the pit and changed to good granulation tissue. To expose the surrounding lesions it has been our practice to first report application of a very tight packing of gauze to the spot selected for the further entry to the lesion to be exposed, and then to enter the lesion by means of pincers or a finger-tip. The entry should be attempted only after the pit wall overlying the lesion to be exposed is made sufficiently brittle in the course of the repeated tamponade, which usually takes one or two weeks because at a later time the tissue of the pit wall granulates and becomes liable to bleeding or gets so hard that it prevents easy exchange of tampons packed in the freshly produced wound. Then the wall of a pit is found to have undergone these disadvantageous changes, it is recommended that the wall of the pit be removed, or a separate pit be constructed.

In short, the correction or extension of the pit track is most safely attempted when a pit is in such a condition that bleeding and exudation subside, and the wall is lined partly with soft granulation tissues, and partly with exposed lung tissues.

When a pit track is extended and a fresh wound is brought into existence, the same treatment as stated above is given to this part, after treating this part by tamponade with iodoform gauze for a certain period of time.

(Although these Notices are needful for Direct Method, we think, they are not almost necessary for Saturing and Retracting Method.)

(III) Plombage of the Draining Pit Track with a Pedunculated Muscular Flap and the Later Case

When the tissue of the pit wall granulates sufficiently, a pedunculated muscular flap is sutured to the pit thereby closing it.

When the patient produces persistently positive sputum, after closing of the pit, we may contemplate the construction of another pit to drain the bacilliferous focus. We consider it of no use, at least of no effect upon the chest involvement, to continue the open treatment of the pit for an indefinitely long time. Since the examination of the sputum for tubercle bacilli turns negative usually on the fifth post operative day, the open treatment thereafter aims simply to improve the surrounding lesions and quicken the granulation. Because the granulation in the pit becomes sufficient usually in the 1st or 2nd post operative month, closure of the pit is performed most often in this period.

As to plombage with the pedunculated muscular flap, not much need be

said except that it should be carried out after the pit track is enlarged a little in the neck part, since it is narrow and deep.

Owing to the fact that thoracoplasty is as a rule avoided in this method, we may encounter some cases in which a big dead space results in the subcutaneous layer from using too big a muscle graft for the plompage. For such instances it is of help to insert a drain subcutaneously within several days after the operation, and then fix it tightly by means of a pressure bandage.

In addition, the draining of the fluid by a needle and the injection of chemotherapeutics may be attempted if necessary.

After the pit is closed, the wound should be carefully attended until it undergoes a sufficient degree of cicatricial healing as evidenced by the color and hardness of the skin.

IV. Post Operative Course

(1) *Body temperature*

Either after a pit is established or after it is closed, the temperature goes up to 100 F at the highest; however, it drops to the normal level within two to five days after it is formed and within one to two weeks after it is closed.

(2) *Urine*

The cases operated upon by this method less frequently give the positive results for the urobilinogen test than those operated upon by cavernostomy with thoracoplasty or thoracoplasty.

(3) *Body Weight*

Those operated upon by this method show a faster recovery of body weight than those operated upon by cavernostomy with thoracoplasty or thoracoplasty.

Most of the cases operated upon by this method recovered by the end of the second postoperative month, and all cases exceeded their previous body weight in later months; while half of the cases operated upon by cavernostomy with thoracoplasty and thoracoplasty failed to recover the previous weight even after the 6th postoperative month.

(4) *Blood Sedimentation Rate*

The sedimentation rate goes up the preoperative level usually in the 3rd postoperative month, then descends slowly till it comes to the normal level. In the cases showing a high rate preoperatively the sedimentation rate draws a slowly descending curve, while in the cases showing a low rate preoperatively the curve is such that it goes up once and then descends.

When it is recalled that cavernostomy with thoracoplasty and thoracoplasty permit only a half of the cases operated upon to obtain the normal rate in the 6th postoperative month it is evident that this method brings about a quicker recovery than cavernostomy or thoracoplasty.

The results of other colloidal tests also support this view.

(5) *Vital Capacity*

It will be naturally imagined that this method causes less of a decrease and a quicker recovery of the vital capacity than cavernostomy with thoracoplasty or thoracoplasty. This has been proved by the results of various tests of lung function.

(6) *Amount of sputum*

This method is in general far superior to thoracoplasty, but a little inferior to cavernostomy with thoracoplasty in its effect to bring about reduction in the amount of sputum.

The bloody sputum disappears usually within a week. However, since this is an open method, it may last longer than in the case of cavernostomy with thoracoplasty.

(7) *Fluctuation of tubercle bacilli in the sputum*

Examinations of the sputum for tubercle bacilli, as shown in Table 1, gave negative results (in repeated culture tests) in 41 cases and positive results in 11 cases, who have passed over six months after the operation. In the table, the number of indication is described in the item of indication as Table 2. (Table 1-2)

Table 1 Tubercle Bacilli in Sputum

Method		Direct Method		Suturing and Retracting Method		Total
Tubercle Bacilli in Sputum Indication		(+)	(-)	(+)	(-)	
A	1	1	8	0	2	11
	2	4	12	1	7	24
B	1	1	4	0	4	9
	2	4	3	0	1	8
Total		10	27	1	14	52
		37		15		

(Note):

The case who has been found tubercle bacilli in sputum by repeated culture test during the past three months, even if only once, is indicated (+).

Table 2 Indication and Contraindication of This Method.

Indication

A. This method alone suffices for the following types of disease;

1. Disease limited to one or two bronchial segments without or with cavities of small size.

2. Disease spread over two or three bronchial segments with out standing main lesion at center.
- B. Combination with some other surgical method is sometimes or always necessary in the following types of disease;
 1. Diseased lung dootted with some number of advanced foci on which no collapse therapy seems to work.
 2. Bilateral disease of a patient in capable of bearing a bilateral collapse therapy.

Contraindication

- A. The case with a great number of or extensive caseous lesions, which have the possibilities in growing the pit too wide by destructing of lung tissues when these are treated openly.
- B. The case with a serious complication etc.

As indicated in Table 1, in cases under B2 we haven't had excessively good results, but that may be natural.

It is noticeable that Suturing and Retracting Method indicate better results than Direct Method.

We consider that in the other cases except those under B2 we have had satisfactory results.

(8) *Tubercle bacilli in the blood*

In 9 cases operated upon by this method we cultured blood six times intermittently during the week following operation, and found no tubercle bacilli in the blood. Just as we learned from our experience with cavernostomy, hematogenous spread seems to occur very rarely when antituberculous remedies are being administered. No sign of hematogenous spread was seen in 52 cases during more than 6 months of their postoperative course.

(9) *Roentgenographic Findings*

Roentgenograms of patients with closed pits showed that the surrounding infiltrations turned into a focus of solid linear shadows while the muscle plug indicated the site of the former main lesion, or in many cases that pathological shadows had almost disappeared. The disease was judged to be getting better.

(10) *The examinations of liver-function*

Several examinations of liver-function were done. On about 5 cases operated upon by this method, before and just after the operation, and intermittently five times during the period of one month following the operation.

The results showed that all cases have recovered to the state before the operation, or even improved beyond the preoperative state.

Compared with results of thoracoplasty, this indicates that the degree of invasion of this method is a lower than that of thoracoplasty.

(11) *A few examinations of pulmonary-function*

The pulmonary function of 9 cases operated upon by this method was examin-

ed four times during period of seven days following the operation, we have the results and were compared with those following thoracoplasty.

This method causes very little impairment of pulmonary function.

To summarize, it is in the first to second postoperative month that the pit wall becomes clean and the granulation attains sufficient proliferation to permit closure; the disease subsides in the 3rd postoperative month; the patients in many instances may engage in light work after the 6th postoperative month.

V. Complications and Unsuccessful Cases

The complications and unsuccessful cases we have experienced are one case of air-embolism, two cases in which pus was formed after plombage with pedunculated muscular flap, (however both have [since recovered) and one case who died because of extensive necrosis of lung tissue during the open treatment.

In addition, in one case anemia of unknown etiology present before operation, progressed gradually after the operation. This patient was given a blood transfusion, and died after several days of nephritis.

The case of air-embolism showed symptom of air-embolism after the removal of a specimen of the wall of the constructed pit by biopsy needle "VIM"; this patient died a month later. Autopsy showed necrosis of the brain. In addition, this patient had a strongly positive Wasserman's test.

The two cases of wound infection after plombage with the pedunculated muscular flap were due to the fact that their pits were too wide and deep for plombage. It may be thought that this subject, has been dissolved after employing Suturing and Retracting Method.

The most serious failure [was the case of extensive necrosis of lung tissue. It is now believed that this case should have been treated by Maurer's method or Monaldi's method.

VI. Limitations of this Method from the Point of View of Pathological Findings

Of the 75 cases operated upon by this method, histopathologic investigation has been performed in 26 cases, and autopsy in one case. The following report deals with the healing process produced by the open treatment of the tuberculous lesion and the histopathologic change that occurs in the surrounding tuberculous lesions and the lung parenchym adjacent to the pit. The specimens were obtained by "Frunwald's forceps" from the pit wall during the operation and at different times in the course of the postoperative stage, that is, the first specimen was obtained during the construction of the pit; the second specimen in the 1st to 2nd postoperative week when bleeding mostly subsides and exudation ceases; the third specimen in the 3rd to 5th postoperative week; the fourth specimen

immediately before the closure of the pit by plombage of a pedunculated muscular flap.

To obtain a specimen of tissue deep in lung through the pit wall, the "VIM" biopsy needle was employed.

As to staining, hematoxylin-eosin staining, van Gieson's staining, Watanabe's silver staining and other methods of staining tubercle bacilli were used.

The specimen obtained upon the initial exposure of the lesions and construction of the pit, revealed a typical picture of the productive form of tuberculosis in most cases except in two patients where round cell infiltration was the predominant picture and no giant-cell nor epitheloid cell infiltration was found at all. The histopathologic investigation of the pit wall during the course of the open treatment revealed the following: increasing infiltration of polymorphonuclear leukocytes and round cells and dilated or proliferating capillaries characterized the picture of the 1st to 2nd postoperative week. After this period collagen fibers were found to proliferate among the round cells. Tubercles were rarely observed. The epitheloid cells were often covered by round cell infiltration. The picture during the 7th postoperative week resembled that of the 3rd to 5th week.

By using a biopsy needle we were able to observe the changes occurring in the tissue up to 3 cm. in depth from the pit wall. Close to the wall, lung parenchyma was at first found in the same condition as the wall, but later, proliferation of collagen fibers stretching out from the wall became prominent as the open treatment advanced. Furthest from the pit wall, the alveolae were found free of exudate, although a large number of round cells were prominent.

The above facts may be recapitulated histopathologically as follows:

(1) The changes brought about by the open treatment in tuberculous lesions are such that the specific inflammatory process subsides, and a non-specific, acute inflammatory process becomes prominent with marked proliferation of granulation tissue.

This reveals the cicatricial healing of tuberculous lesions.

(2) The lung parenchyma around the pit, particularly the tuberculous lesions lying at a depth of ca. 3 cm from the pit wall, undergoes a cirrhotic change caused by the mild stimulus produced by the open treatment.

The open treatment by means of the draining pit has proved effective to the surrounding lung parenchyma, particularly to tuberculous lesions. However, a lesion showing a certain degree of conglomeration lying at a depth exceeding ca. 3 cm. from the pit wall escapes cicatricial healing, even though it may be brought to a productive cirrhotic state by the open treatment. The co-existence of a main lesion side by side with such an adjacent lesion as the aforementioned, may indicate the advisability of the construction of two pits established either separately or in the form of a pit giving rise to a branch at a certain spot.

But we are of the opinion that aimed main lesions and the adjacent lesions should be treated openly together and at the same time after the performance of a pneumolysis so that the lesion may shrink prior to the pit construction by Suturing and Retracting Method.

VII. Indication for & Characteristics of This Method

Our experience with this method in 75 cases has led us to recognize the indications for this method as Table 2.

Since this method owes its practicability to the recent appearance of excellent anti-tuberculous remedies, it is expected that future advances in the field of anti-tuberculous remedies will expand the indications for this method and secure better results with a shorter period of treatment.

This method is characterized by the features shown in Table 3.

Table 3 Characteristic Features of This Method

- (1) This method, especially Direct Method, is mild in the point of operative invasion.
- (2) This method promotes the cicatricial healing of the lesions.
- (3) This method does not cause a serious deformity of the chest.
- (4) This method may be combined with other surgical operations.

Summary

An open surgical treatment of tuberculous cavities and caseous lesions which have not yet become cavities has been established. We have named this method tentatively "The open drainage of the Affected Lung areas by Means of Surgically constructed Pit."

The operative technique and indications have been reported in this paper.

Although the real value of this method should be estimated on the basis of the results of longer follows-up, the results up to date have been better than we anticipated. The author hopes that this report will call the attention of those concerned to the study of this subject.

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